

ION EXCHANGE AND ZEOLITES

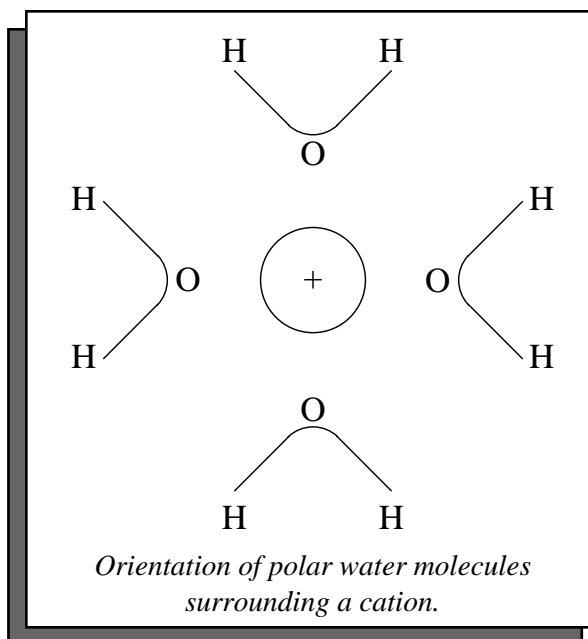
4.31 Introduction

Ion exchange is based on the simple idea that electrically charged particles (ions) with unlike charges attract each other. Ions with a negative charge are anions. Ions with a positive charge are cations.

4.32 Dissolving Ionic Compounds

If you place table salt (NaCl) in water, the salt dissolves. What happens is that water molecules, H_2O , are very effective at breaking the ionic bonds and keeping Na^+ and Cl^- separated (dissolved) in solution. The water molecule is electrically neutral, but, because the molecule is bent, one side has a slight negative charge

while the other side has a slight positive charge. This makes the water molecule a “polar” molecule. Its positive pole is attracted to anions like Cl^- while its negative pole is attracted to cations like Na^+ . In solution, water molecules surround the cations and anions and keep them separated. Because ionic compounds dissolve readily in water, any radioactive isotopes that can exist as ions in water will move with the water.



What is the basis of ion exchange?

What happens when salt dissolves in water?

Precipitation

What are the two ways to remove ions from a solution?

What happens when ions are removed from water by precipitation?

Removing ions from solution is done in two ways, *precipitation* or *ion exchange*. If the amount of water is decreased, there are fewer water molecules to separate and isolate ions from one another. One way to decrease the amount of water in a solution is to evaporate the water, usually by heating it. The water molecules leave as water vapor (steam) and the ions are concentrated in the remaining water. Eventually, there won't be enough water remaining to keep all the ions from attracting each other. The ionic compounds, containing cations and anions, will begin to *precipitate* (fall out of solution).

Ion Exchange

What happens during ion exchange?

What is a zeolite?

A second way to remove ions from solution is by ion exchange. A cation ion exchanger is basically a framework with a negative charge that has positive cations attached to it. The framework is like the bars of a cage which carry a negative charge, and cations fill the open spaces. A zeolite is a naturally occurring ion exchanger.

How would a zeolite remove contaminants from water?

Depending on the composition of the water around a zeolite, cations attached to a zeolite can change places with cations in the water. If water containing waste were released from the repository, it might be carrying the radioactive cations cesium-137 and strontium-90. Cesium-137 is similar in behavior to potassium (K^+), and strontium-90 is similar in behavior to calcium (Ca^{2+}). As the waste passes the zeolite, the cesium-137 and strontium-90 would displace loosely held exchange cations (Na^+) on the zeolite. The result is that the radioactive cations would attach to the zeolite, and the water leaving the zeolite zone would contain the displaced, non-radioactive cations.